

EXECUTIVE SUMMARY

Thank you for your continued hard work sampling **Knowles Pond** this year! Your monitoring group sampled the deep spot **three** times this year and has done so for many years. As you know, conducting multiple sampling events each year enables DES to more accurately detect water quality changes. Keep up the good work!

Finally, please remember that one of your most important responsibilities as a volunteer monitor is to educate your association, community, and town officials about the quality of your lake and what can be done to protect it! DES biologists may be able to assist you in educating your association members by attending your annual lake association meeting.

OBSERVATIONS & RECOMMENDATIONS

DEEP SPOT

➤ **Chlorophyll-a**

Chlorophyll-a, a pigment found in plants, is an indicator of algal abundance. Algae are typically microscopic plants that are naturally found in the lake ecosystem. The measurement of chlorophyll-a in the water gives biologists an estimation of the algal concentration or lake productivity. Table 14 in Appendix A lists the current year chlorophyll-a data.

Figure 1 depicts the historical and current year chlorophyll-a concentration in the water column.

The median summer chlorophyll-a concentration for New Hampshire's lakes and ponds is 4.58 mg/m³.

The current year data (the top graph) show that the chlorophyll-a concentration **increased** from **June** to **July**, and then **decreased** from **July** to **September**.

The historical data (the bottom graph) show that the **2007** chlorophyll-a mean is **slightly less than** the state and similar lake medians. For more information on the similar lake median, refer to Appendix D.

Overall, visual inspection of the historical data trend line (the bottom graph) shows an **increasing** in-lake chlorophyll-a trend since monitoring began. Specifically the mean chlorophyll concentration has **worsened** since **2001**.

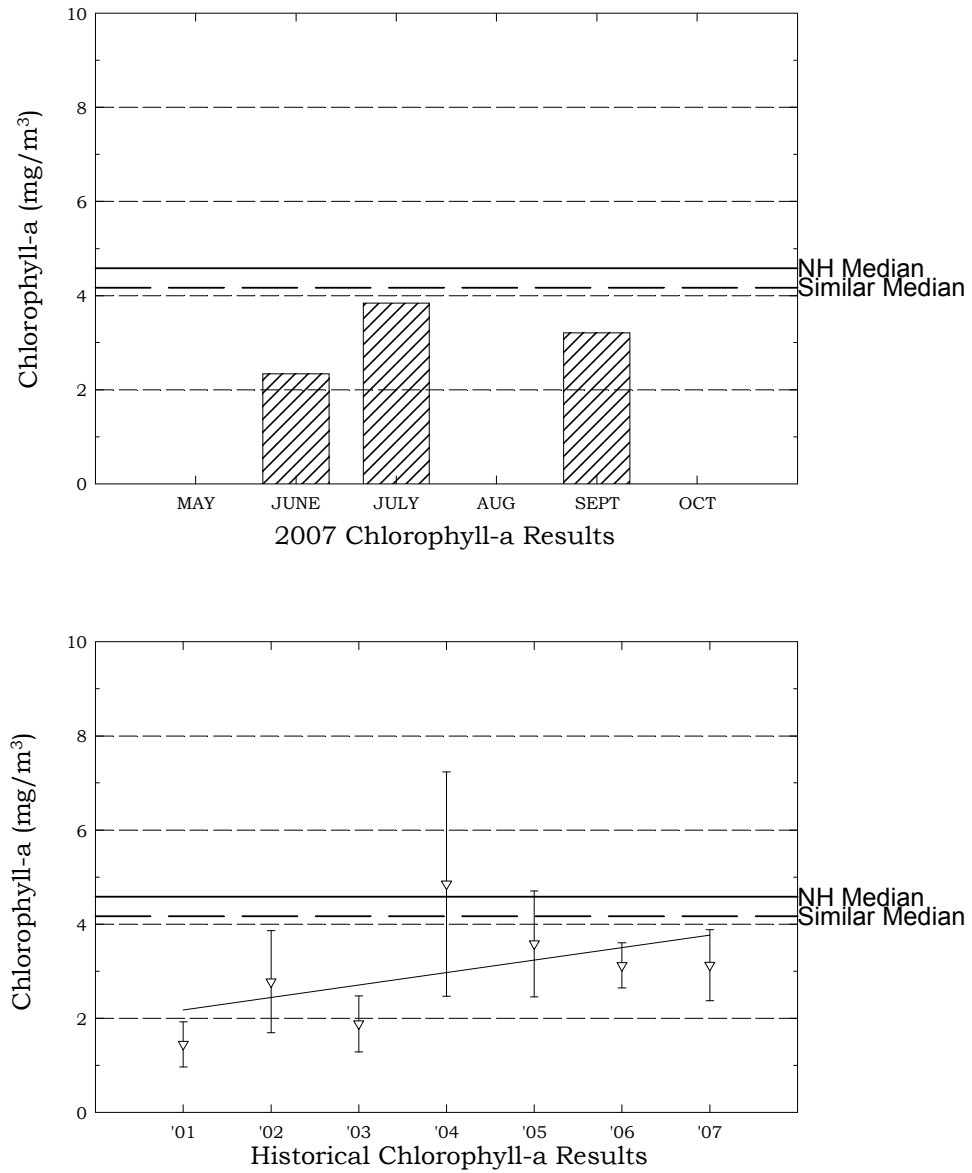
Please keep in mind that this trend is based on only **seven** years of data. After 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean transparency since monitoring began.

While algae are naturally present in all waterbodies, an excessive or increasing amount of any type is not welcomed. Phosphorus is the nutrient that algae typically depend upon for growth in New Hampshire lakes and ponds. Algal concentrations increase as nonpoint sources of phosphorus from the watershed increase, or as in-lake phosphorus sources increase. Increased Chlorophyll-a concentrations can also affect water clarity, causing Secchi-disk transparency to decrease (worsen) and turbidity to increase (worsen).

Therefore, it is extremely important for volunteer monitors to continually educate all watershed residents about management practices that can be implemented to minimize phosphorus loading to surface waters.

Knowles Pond, Northfield

Figure 1. Monthly and Historical Chlorophyll-a Results



➤ **Phytoplankton and Cyanobacteria**

Table 1 lists the phytoplankton (algae) and/or cyanobacteria observed in the pond in **2007**. Specifically, this table lists the three most dominant phytoplankton and/or cyanobacteria observed and their relative dominance in the sample.

Table 1. Dominant Phytoplankton/Cyanobacteria (July 2007)

Division	Genus	% Dominance
Chrysophyta	Synura	86.0
Chrysophyta	Mallomonas	7.0
Chrysophyta	Dinobryon	7.0

Phytoplankton populations undergo a natural succession during the growing season. Please refer to the “Biological Monitoring Parameters” section of this report for a more detailed explanation regarding seasonal plankton succession. Diatoms and golden-brown algae populations are typical in New Hampshire’s less productive lakes and ponds.

➤ **Secchi Disk Transparency**

Volunteer monitors use the Secchi disk, a 20 cm disk with alternating black and white quadrants, to measure how far a person can see into the water. Transparency, a measure of water clarity, can be affected by the amount of algae and sediment in the water, as well as the natural color of the water. Table 14 in Appendix A lists the current year transparency data. **The median summer transparency for New Hampshire’s lakes and ponds is 3.2 meters.**

Figure 2 depicts the historical and current year transparency *with and without* the use of a viewscope.

The current year data (the top graph) includes both the non-viewscope and viewscope readings for **2007**.

The current year *non-viewscope* in-lake transparency *gradually decreased* from **June** through **September**.

It is important to note that as the chlorophyll concentration *increased* from **June** to **July**, the transparency *decreased*. We typically expect this *inverse* relationship in lakes. As the amount of algal cells in the water *increases*, the depth to which one can see into the water column typically *decreases*, and vice-versa.

The viewscope in-lake transparency was *greater than* the non-viewscope transparency on the **July** sampling event. The transparency was *not* measured

with the viewscope on the **June** or **September** sampling events. As discussed previously, a comparison of transparency readings taken with and without the use of a viewscope shows that the viewscope typically increases the depth to which the Secchi disk can be seen into the lake, particularly on sunny and windy days. We recommend that your group measure Secchi disk transparency with and without the viewscope on each sampling event.

It is important to note that viewscope transparency data are not compared to a New Hampshire median or similar lake median. This is because lake transparency with the use of a viewscope has not been historically measured by DES. In the future, the New Hampshire and similar lake medians for viewscope transparency will be calculated and added to the appropriate graphs.

The historical data (the bottom graph) show that the **2007** mean non-viewscope transparency is ***much greater than*** the state median and is ***slightly greater than*** the similar lake median. Please refer to Appendix D for more information about the similar lake median.

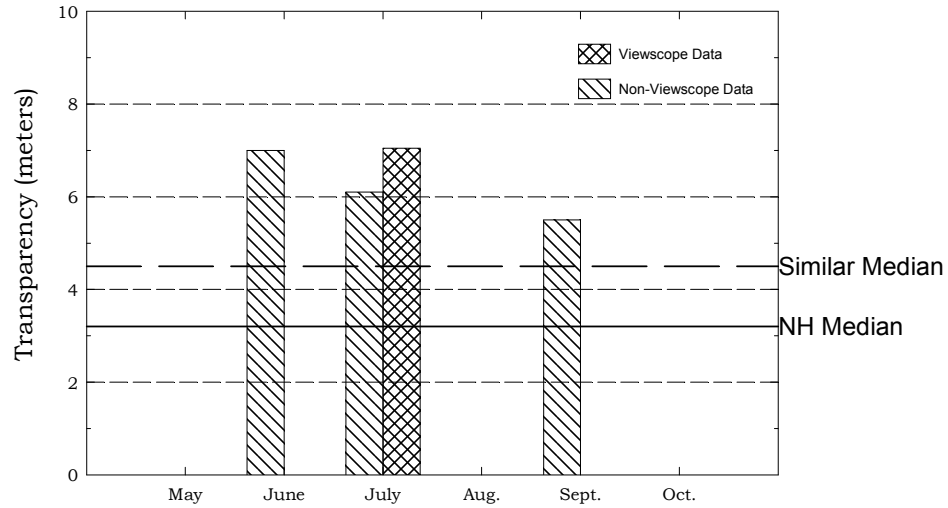
Visual inspection of the historical data trend line (the bottom graph) shows a ***variable*** trend. Specifically, the transparency has ***fluctuated between approximately 4.95 and 8.47 meters*** since monitoring began in **2001**.

Please keep in mind that this trend is based on only **seven** years of data. After 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean transparency since monitoring began.

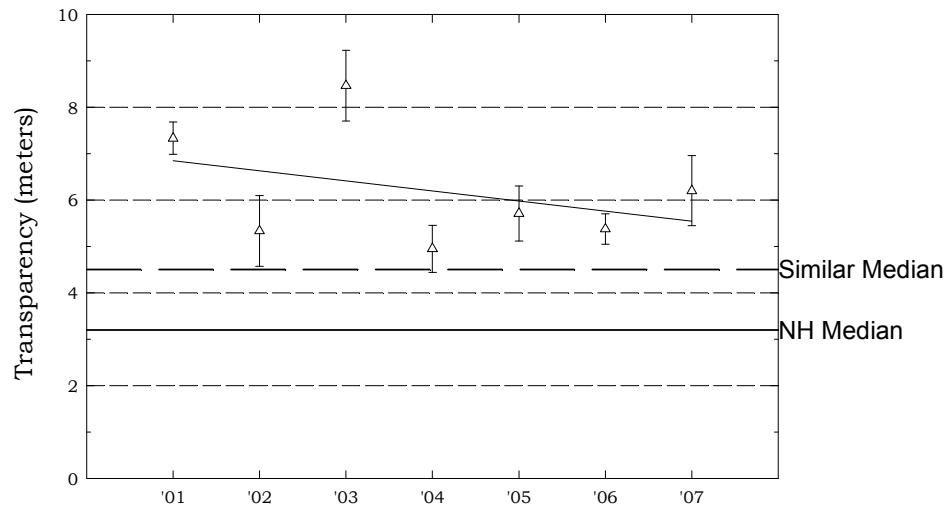
Typically, high intensity rainfall causes sediment-laden stormwater runoff to flow into surface waters, thus increasing turbidity and decreasing clarity. Efforts should continually be made to stabilize stream banks, pond shorelines, disturbed soils within the watershed, and especially dirt roads located immediately adjacent to the edge of tributaries and the pond. Guides to best management practices that can be implemented to reduce, and possibly even eliminate, nonpoint source pollutants, are available from DES upon request.

Knowles Pond, Northfield

Figure 2. Monthly and Historical Transparency Results



2007 Transparency Viewscope and Non-Viewscope Results



Historical Transparency Non-Viewscope Results

➤ **Total Phosphorus**

Phosphorus is typically the limiting nutrient for vascular plant and algae growth in New Hampshire's lakes and ponds. Excessive phosphorus in a pond can lead to increased plant and algal growth over time. Table 14 in Appendix A lists the current year total phosphorus data for in-lake and tributary stations. **The median summer total phosphorus concentration in the epilimnion (upper layer) of New Hampshire's lakes and ponds is 12 ug/L. The median summer phosphorus concentration in the hypolimnion (lower layer) is 14 ug/L.**

The graphs in Figure 3 depict the historical amount of epilimnetic (upper layer) and hypolimnetic (lower layer) total phosphorus concentrations; the inset graphs depict current year total phosphorus data.

The current year data for the epilimnion (the top inset graph) show that the phosphorus concentration **remained stable** from **June** to **July**, and then **increased slightly** from **July** to **September**.

The historical data show that the **2007** mean epilimnetic phosphorus concentration is **much less than** the state median and is **slightly less than** the similar lake median. Refer to Appendix D for more information about the similar lake median.

The current year data for the hypolimnion (the bottom inset graph) show that the phosphorus concentration **gradually increased** from **June** through **September**.

The historical data show that the **2007** mean hypolimnetic phosphorus concentration is **approximately equal to** the state and similar lake medians. Please refer to Appendix D for more information about the similar lake median.

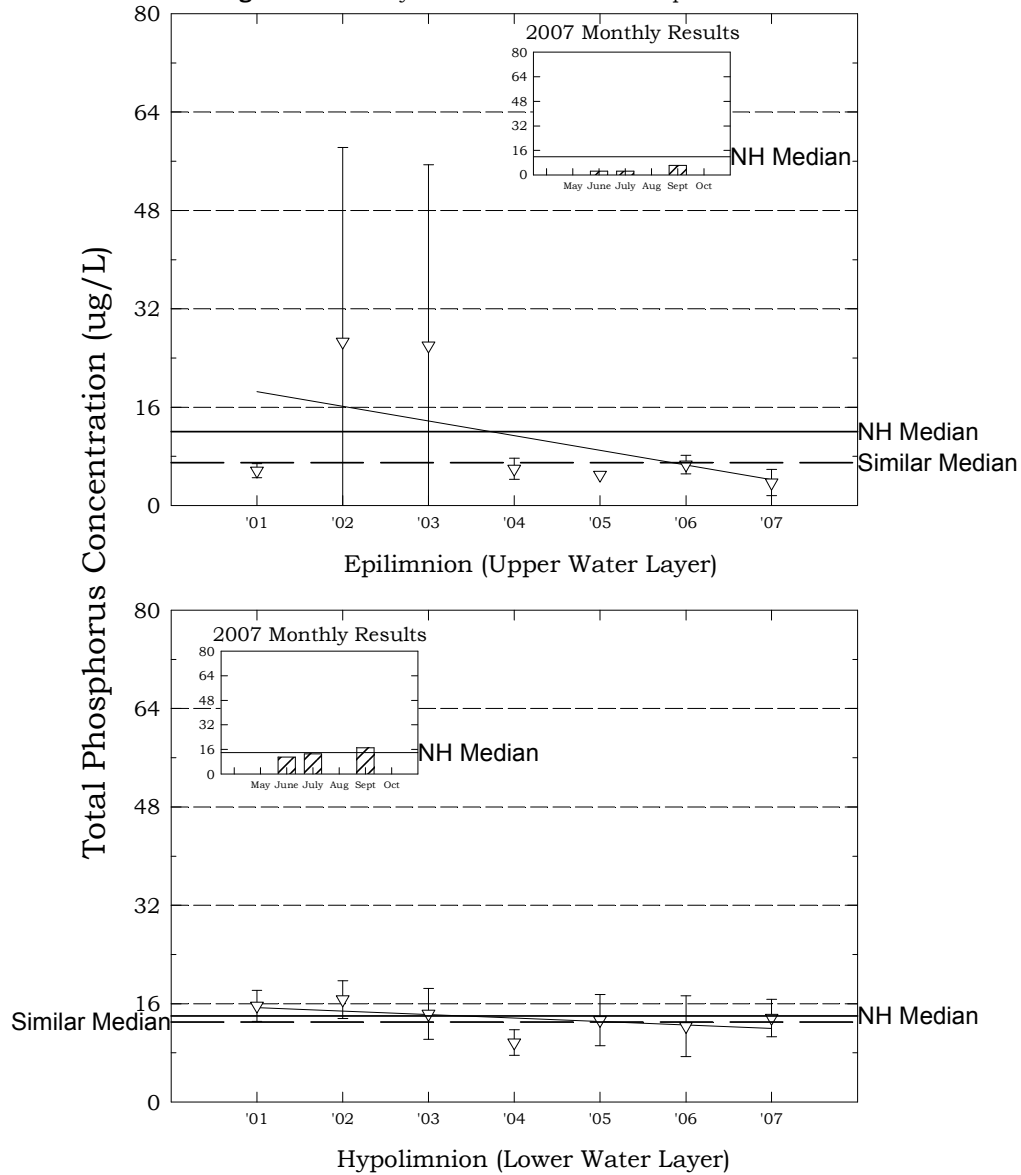
Overall, visual inspection of the historical data trend line for the epilimnion and hypolimnion shows a **slightly decreasing** phosphorus trend since monitoring began. Specifically the mean annual epilimnetic and hypolimnetic phosphorus concentration has **improved** since monitoring began in **2001**.

As discussed previously, after 10 consecutive years of sample collection, we will be able to conduct a statistical analysis of the historical data to objectively determine if there has been a significant change in the annual mean phosphorus concentration since monitoring began.

One of the most important approaches to reducing phosphorus loading to a waterbody is to continually educate watershed residents about the watershed sources of phosphorus and how excessive phosphorus loading can negatively affect the ecology and the recreational, economical, and ecological value of lakes and ponds.

Knowles Pond, Northfield

Figure 3. Monthly and Historical Total Phosphorus Data.



➤ pH

Table 14 in Appendix A presents the current year pH data for the in-lake stations.

pH is measured on a logarithmic scale of 0 (acidic) to 14 (basic). pH is important to the survival and reproduction of fish and other aquatic life. A pH below 6.0 typically limits the growth and reproduction of fish. A pH between 6.0 and 7.0 is ideal for fish. The median pH value for the epilimnion (upper layer) in New Hampshire's lakes and ponds is **6.6**, which indicates that the state surface waters are slightly acidic. For a more detailed explanation regarding pH, please refer to the "Chemical Monitoring Parameters" section of this report.

The pH at the deep spot this year ranged from **5.86 to 6.87** in the epilimnion and from **5.49 to 5.66** in the hypolimnion, which means that the water is **slightly acidic**.

It is important to point out that the hypolimnetic (lower layer) pH was **lower (more acidic)** than in the epilimnion (upper layer). This increase in acidity near the bottom is likely due to the decomposition of organic matter and the release of acidic by-products into the water column.

Due to the state's abundance of granite bedrock and acid deposition received from snowmelt, rainfall, and atmospheric particulates, there is little that can be feasibly done to effectively increase pond pH. The pH at the deep spot, however, is sufficient to support aquatic life.

➤ Acid Neutralizing Capacity (ANC)

Table 14 in Appendix A presents the current year epilimnetic ANC for the deep spot.

Buffering capacity (ANC) describes the ability of a solution to resist changes in pH by neutralizing the acidic input. The median ANC value for New Hampshire's lakes and ponds is **4.9 mg/L**, which indicates that many lakes and ponds in the state are at least "moderately vulnerable" to acidic inputs. For a more detailed explanation about ANC, please refer to the "Chemical Monitoring Parameters" section of this report.

The acid neutralizing capacity (ANC) of the epilimnion (upper layer) ranged from **1.0 mg/L to 1.8 mg/L**. This indicates that the pond is **extremely vulnerable** to acidic inputs.

➤ Conductivity

Table 14 in Appendix A presents the current conductivity data for in-lake stations.

Conductivity is the numerical expression of the ability of water to carry an electric current, which is determined by the number of negatively charged ions from metals, salts, and minerals in the water column. The median conductivity value for New Hampshire's lakes and ponds is **40.0 uMhos/cm**. For a more detailed explanation, please refer to the "Chemical Monitoring Parameters" section of this report.

The conductivity in the pond is relatively **stable** and **low**. Typically conductivity levels greater than 100 uMhos/cm indicate the influence of pollutant sources associated with human activities. These sources include septic system leachate, agricultural runoff, and road runoff which contains road salt during the spring snow-melt. We hope this trend continues!

➤ Dissolved Oxygen and Temperature

Table 9 in Appendix A depicts the dissolved oxygen/temperature profile(s) collected during **2007**.

The presence of sufficient amounts of dissolved oxygen in the water column is vital to fish and amphibians and also to bottom-dwelling organisms. Please refer to the "Chemical Monitoring Parameters" section of this report for a more detailed explanation.

The dissolved oxygen concentration was greater than **100 percent** saturation between **5.0** and **9.0** meters at the deep spot on the **July** sampling event. Wave action from wind can also dissolve atmospheric oxygen into the upper layers of the water column. Layers of algae can also increase the dissolved oxygen in the water column, since oxygen is a by-product of photosynthesis. Considering that the depth to which sunlight could penetrate into the water column was approximately **7.0** meters on this sampling event, as shown by the Secchi disk transparency depth, and that the metalimnion, the layer of rapid decrease in water temperature and increase in water density where algae typically congregate, was located between approximately **5.0** and **9.0** meters, we suspect that an abundance of algae in the metalimnion caused the oxygen super-saturation.

The dissolved oxygen concentration was **lower in the hypolimnion (lower layer) than in the epilimnion (upper layer)** at the deep spot on the **July** sampling event. As stratified ponds age, and as the summer progresses, oxygen typically becomes **depleted** in the hypolimnion by the process of decomposition. Specifically, the reduction of hypolimnetic oxygen is primarily a result of biological organisms using oxygen to break down organic matter, both in the water column and particularly at the bottom of the pond where the water meets the sediment. When the hypolimnetic oxygen concentration is depleted

to less than 1 mg/L, the phosphorus that is normally bound up in the sediment may be re-released into the water column, a process referred to as ***internal phosphorus loading***.

This year the DES biologist collected the dissolved oxygen profile in **July**. We recommend that the annual biologist visit for the **2008** sampling year be scheduled during **August** so that we can determine if oxygen is depleted in the hypolimnion ***later*** in the sampling year.

➤ **Turbidity**

Table 14 in Appendix A presents the current year data for in-lake turbidity.

Turbidity in the water is caused by suspended matter, such as clay, silt, and algae. Water clarity is strongly influenced by turbidity. Please refer to the “Other Monitoring Parameters” section of this report for a more detailed explanation.

The turbidity of the metalimnion (middle layer) sample was ***slightly elevated (1.58 NTUs)*** on the **September** sampling event. This suggests that a layer of algae may have been present at this location. Algae are often found in the metalimnion of ponds due to the differences in density between the epilimnion and the hypolimnion and the resulting abundance of food in that layer.

The hypolimnetic (lower layer) turbidity was ***slightly elevated (1.47 NTUs)*** on the **September** sampling event. In addition, the hypolimnetic turbidity has been elevated on many sampling events during previous sampling years. This suggests that the pond bottom may have been disturbed by the anchor or by the Kemmerer Bottle while sampling and/or that the lake bottom is covered by an easily disturbed thick organic layer of sediment. When the pond bottom is disturbed, phosphorus rich sediment is released into the water column. When collecting the hypolimnion sample, make sure that there is no sediment in the Kemmerer Bottle before filling the sample bottles.

TRIBUTARY SAMPLING

➤ **Total Phosphorus**

Table 14 in Appendix A presents the current year total phosphorus data for tributary stations. Please refer to the “Chemical Monitoring Parameters” section of the report for a detailed explanation of total phosphorus.

Overall, tributary phosphorus concentration(s) were **very low** in **2007**. The dry weather conditions likely reduced the amount of phosphorus laden stormwater runoff to the tributaries.

➤ **pH**

Table 14 in Appendix A presents the current year pH data for the tributary stations. Please refer to the “Chemical Monitoring Parameters” section of this report for a more detailed explanation of pH.

The pH of the tributary station(s) ranged from **6.16 to 6.37 (> 6)** and is sufficient to support aquatic life.

➤ **Conductivity**

Table 14 in Appendix A presents the current conductivity data for the tributary stations. Please refer to the “Chemical Monitoring Parameters” section of the report for a more detailed explanation of conductivity.

Overall, the conductivity has **gradually decreased** in the tributaries since monitoring began. We hope to see this continue!

➤ **Turbidity**

Table 14 in Appendix A presents the current year turbidity data for the tributary stations. Please refer to the “Other Monitoring Parameters” section of the report for a more detailed explanation of turbidity.

Overall, **2007** tributary turbidity levels were **similar** to historical tributary turbidity levels.

➤ **Bacteria (*E. coli*)**

Table 14 in Appendix A lists the current year data for bacteria (*E.coli*) testing. *E. coli* is a normal bacterium found in the large intestine of humans and other warm-blooded animals. *E.coli* is used as an indicator organism because it is

easily cultured and its presence in the water, in defined amounts, indicates that sewage **may** be present. If sewage is present in the water, potentially harmful disease-causing organisms **may** also be present. Please refer to the “Other Monitoring Parameters” section of the report for a more detailed explanation.

The *E. coli* concentration was **very low** at the **Beach** for each sampling event. Specifically, each result was **2 counts or less**, which is ***much less than*** the state standard of 406 counts per 100 mL for recreational surface waters that are not designated public beaches and 88 counts per 100 mL for surface waters that are designated public beaches.

➤ **Chlorides**

Table 14 in Appendix A lists the current year data for chloride sampling. The chloride ion (Cl⁻) is found naturally in some surface waters and groundwaters and in high concentrations in seawater. Research has shown that elevated chloride levels can be toxic to freshwater aquatic life. In order to protect freshwater aquatic life in New Hampshire, the state has adopted **acute and chronic** chloride criteria of **860 and 230 mg/L** respectively. The chloride content in New Hampshire lakes is naturally low, generally less than 2 mg/L in surface waters located in remote areas away from habitation. Higher values are generally associated with salted highways and, to a lesser extent, with septic inputs. Please refer to the “Chemical Monitoring Parameters” section of this report for a more detailed explanation.

Chloride sampling was **not** conducted during **2007**.

DATA QUALITY ASSURANCE AND CONTROL

Annual Assessment Audit

Annual Assessment Audit:

During the annual visit to your pond, the biologist conducted a sampling procedures assessment audit for your monitoring group. Specifically, the biologist observed the performance of your monitoring group while sampling and filled-out an assessment audit sheet to document the volunteer monitors’ ability to follow the proper field sampling procedures, as outlined in the VLAP Monitor’s Field Manual. This assessment is used to identify any aspects of sample collection in which volunteer monitors failed to follow proper procedures, and also provides an opportunity for the biologist to retrain the volunteer monitors as necessary. This will ultimately ensure that the samples volunteer monitors collect are truly representative of actual lake and tributary conditions.

Overall, your monitoring group did an **excellent** job collecting samples on the annual biologist visit this year! Specifically, the members of your monitoring

group followed the proper field sampling procedures and there was no need for the biologist to provide additional training. Keep up the good work!

Sample Receipt Checklist

Each time your monitoring group dropped off samples at the laboratory this summer, the laboratory staff completed a sample receipt checklist to assess and document if your group followed proper sampling techniques when collecting the samples. The purpose of the sample receipt checklist is to minimize, and hopefully eliminate, improper sampling techniques.

Overall, the sample receipt checklist showed that your monitoring group did an **excellent** job when collecting samples and submitting them to the laboratory this year! Specifically, the members of your monitoring group followed the proper field sampling procedures and there was no need for the laboratory staff to contact your group with questions, and no samples were rejected for analysis.

USEFUL RESOURCES

Acid Deposition Impacting New Hampshire's Ecosystems, DES fact sheet ARD-32, (603) 271-2975 or www.des.nh.gov/factsheets/ard/ard-32.htm.

Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, DES Booklet WD-03-42, (603) 271-2975.

Canada Geese Facts and Management Options, DES fact sheet BB-53, (603) 271-2975 or www.des.nh.gov/factsheets/bb/bb-53.htm.

Cyanobacteria in New Hampshire Waters Potential Dangers of Blue-Green Algae Blooms, DES fact sheet WMB-10, (603) 271-2975 or www.des.nh.gov/factsheets/wmb/wmb-10.htm.

Erosion Control for Construction in the Protected Shoreland Buffer Zone, DES fact sheet WD-SP-1, (603) 271-2975 or www.des.nh.gov/factsheets/sp/sp-1.htm.

Freshwater Jellyfish In New Hampshire, DES fact sheet WD-BB-5, (603) 271-2975 or www.des.nh.gov/factsheets/bb/bb-51/htm.

Impacts of Development Upon Stormwater Runoff, DES fact sheet WD-WQE-7, (603) 271-2975 or www.des.nh.gov/factsheets/wqe/wqe-7.htm.

IPM: An Alternative to Pesticides, DES fact sheet WD-SP-3, (603) 271-2975 or www.des.nh.gov/factsheets/sp/sp-3.htm.

Iron Bacteria in Surface Water, DES fact sheet WD-BB-18, (603) 271-2975 or www.des.nh.gov/factsheets/bb/bb-18.htm.

Lake Foam, DES fact sheet WD-BB-4, (603) 271-2975 or www.des.nh.gov/factsheets/bb/bb-5.htm.

Lake Protection Tips: Some Do's and Don'ts for Maintaining Healthy Lakes, DES fact sheet WD-BB-9, (603) 271-2975 or www.des.nh.gov/factsheets/bb/bb-9.htm.

Low Impact Development Hydrologic Analysis. Manual prepared by Prince George's County, Maryland, Department of Environmental Resources. July 1999. To access this document, visit www.epa.gov/owow/nps/lid_hydr.pdf or call the EPA Water Resource Center at (202) 566-1736.

Low Impact Development: Taking Steps to Protect New Hampshire's Surface Waters, DES fact sheet WD-WMB-16, (603) 271-2975 or www.des.nh.gov/factsheets/wmb/wmb-17.htm.

Proper Lawn Care In the Protected Shoreland, The Comprehensive Shoreland Protection Act, DES fact sheet WD-SP-2, (603) 271-2975 or www.des.nh.gov/factsheets/sp/sp-2.htm.

Road Salt and Water Quality, DES fact sheet WD-WMB-4, (603) 271-2975 or www.des.nh.gov/factsheets/wmb/wmb-4.htm.

Sand Dumping - Beach Construction, DES fact sheet WD-BB-15, (603) 271-2975 or www.des.nh.gov/factsheets/bb/bb-15.htm.

Shorelands Under the Jurisdiction of the Comprehensive Shoreland Protection Act, DES fact sheet SP-4, (603) 271-2975 or www.des.nh.gov/factsheets/sp/sp-4.htm.

Soil Erosion and Sediment Control on Construction Sites, DES fact sheet WQE-6, (603) 271-2975 or www.des.nh.gov/factsheets/wqe/wqe-6.htm.

Through the Looking Glass: A Field Guide to Aquatic Plants, North American Lake Management Society, 1988, (608) 233-2836 or www.nalms.org.

Weed Watchers: An Association to Halt the Spread of Exotic Aquatic Plants, DES fact sheet WD-BB-4, (603) 271-2975 or www.des.nh.gov/factsheets/bb/bb-4.htm.

Watershed Districts and Ordinances, DES fact sheet WD-WMB-16, (603) 271-2975 or www.des.nh.gov/factsheets/wmb/wmb-16.htm.